

KEYS TO THE LARVAL AND ADULT MOSQUITOES OF ESPIRITU SANTO (NEW HEBRIDES) WITH NOTES ON THEIR BIONOMICS¹

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Buxton, who spent four months in the New Hebrides, recorded only thirteen species during the time of his visit. At this time, even though collections were made during the dry season, indications were that a rich mosquito fauna would in all probability never be found.

A total of eighteen species was collected during the time spent by the author in the New Hebrides. Limited collections were made from the islands of Efate, Malo, Eissi, Tutuba, Aore, Malekula, and Tangoa.

These keys are based upon reared and collected material made from Espiritu Santo (New Hebrides) during a year's observations throughout the dry and wet seasons. The only anopheline found was *Anopheles farauti* Lav. which was present on all the islands of the group except Tutuba and Eissi. No attempt is made in these keys to give specific characters for identification of this species, for they are well covered elsewhere. All collections and observations were restricted to the coastal areas and none is available for elevations over 1000 feet.

KEY TO FOURTH INSTAR LARVAE

1. Air tube lacking; palmate hairs present on abdomen. Tribe *Anophelini*.....*Anopheles farauti* Lav.
- Air tube present; abdomen without palmate hairs. Tribe *Culicini*2
2. Thorax and abdomen with rosettes of short, spine-like setae; air tube with a series of single or double hair tufts dorsally. Genus *Tripteroides*.....*Tripteroides caledonica* Edw.
- Not as above.....3
3. Apical one-third of air tube much thinner and with saw-tooth projections adapted for piercing the roots of aquatic plants. Genus *Mansonia*.....*Mansonia xanthogaster* Edw.
- Air tube of cylindrical or normal shape.....4

¹The opinions expressed in this article are those of the author and are not to be construed as reflecting the views of the Navy Department or the Naval Service at large.

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4. Air tube with several pairs of ventral hair tufts. Genus *Culex*.....5
- Air tube with one pair of ventral hair tufts nearly centrally placed. Genus *Aedes*, *Uranotaenia*.....11
5. Air tube with 12 to 16 ventral hair tufts; upper and lower head hairs single. (Siphon index 7:1).....*Culex femineus* Edw.
- Air tube with 2 to 6 ventral hair tufts; upper and lower head hairs double or multiple.....6
6. A pair of large recurved spines at tip of air tube. (Siphon index 6:1).....*Culex basicinctus* Edw.
- No large recurved spines at tip of air tube.....7
7. Upper and lower head hairs double and plumose; air tube often with a dark band medially; four pairs of rather inconspicuous ventral hair tufts. (Siphon index 8:1 to 9:1).....*Culex fraudatrix* Theo.
- Upper and lower head hairs multiple and plumose; air tube unbanded and with conspicuous ventral hair tufts.....8
8. Air tube with 4 to 6 ventral hair tufts.....9
- Air tube with 2 to 3 ventral hair tufts.....10
9. Anal gills short and bulbous; one pair of subapical hair tufts on air tube. (Siphon index 5:1).....*Culex jepsoni* Theo.
- Anal gills long and tapered; no subapical hair tuft on air tube. (Siphon index variable from 4.5:1 to 8:1).....*Culex annulirostris* Skuse
10. Air tube usually widest one-third distance from base; setae on basal $\frac{2}{3}$ of antennae slender and tapered. (Siphon index 3.5:1).....*Culex quinquefasciatus* Say.
- Air tube tapered from base; setae on basal $\frac{2}{3}$ of antennae stout and blunt. (Siphon index 4:1).....*Culex pacificus* Edw.
11. Air tube with apical one-third of pecten teeth more widely spaced.....12
- Air tube with pecten teeth rather evenly spaced throughout.....13
12. Upper and lower head hairs multiple; lateral comb of about 12 scales; individual comb scales not strongly chitinized and fringed around the upper half.....*Aedes funereus ornatus* Theo.
- Upper and lower hairs single or double; lateral comb of about 8 scales; individual comb scales pointed, heavily chitinized, and fringed basally.....*Aedes vexans* Meig.
13. Scales of lateral comb in a patch and arranged irregularly.....14
- Scales of lateral comb in a single row and arranged regularly.....15
14. Pecten teeth 8-9 in number; comb scales rather heavily chitinized with about 25 scales arranged irregularly in three uneven rows.....*Aedes vigilax* Skuse
- Pecten teeth 15-16 in number; comb scales rather lightly chitinized with about 50-60 scales arranged irregularly in a large yellow patch.....*Aedes raggyi* S. & B.

15. Chitinized thornlike process at the base of the ventrolateral hair tuft on the metathorax large and conspicuous.....
.....*Aedes aegypti* Linn.
- Chitinized thornlike process at the base of the ventrolateral hair tuft on the metathorax small and rather inconspicuous.....
.....16
16. Anal segment with sclerotic plate complete.....17
- Anal segment with sclerotic plate incomplete.....
.....*Aedes hebrideus* Edw.
17. Individual scales of lateral comb strongly spined basally.....
.....*Aedes pernotatus* F. & B.
- Individual scales of lateral comb without any spines or any fringe; upper and lower head hairs spike-like.....
.....*Uranotaenia tibialis* Taylor

KEY TO ADULT FEMALES

1. Palpi of female as long as proboscis, or nearly so; scutellum evenly rounded; wings spotted with areas of dark scales; palpi of male long and clubbed at tip. Tribe *Anophelini*.....
.....*Anopheles farauti* Lav.
- Palpi of female shorter than proboscis; scutellum with posterior margin distinctly tri-lobed; wings unspotted; palpi of male not clubbed at tip. Tribe *Culicini*.....2
2. Proboscis generally as long or longer than the body; dorsal apical abdominal bands usually present; a light stripe across the sides of the thorax marked with white scales, the darker parts nearly bare.....*Tripteroides caledonica* Edw.
- Proboscis shorter than the body; no dorsal apical abdominal bands; sides of thorax without such markings.....3
3. Second marginal cell less than half as long as its petiole; small species (Genus *Uranotaenia*).....
.....*Uranotaenia tibialis* Taylor
- Second marginal cell normal, as long or longer than its petiole.....4
4. Postspiracular bristles absent.....5
- Postspiracular bristles present. Genus *Aedes*.....12
5. First hind tarsal segment shorter than tibia; large and bright orange-yellow species.....*Mansonia xanthogaster* Edw.
- First hind tarsal segment as long as tibia; dull colored species. Genus *Culex*.....6
6. Proboscis and tarsi with distinct pale rings.....7
- Proboscis and tarsi dark. (In *Culex pacificus*, the male only has a narrow ill-defined pale ring on the proboscis).....9
7. Dorsal area of vertex golden-brown, black on either side; anterior half or more of mesonotum clothed with pale scales.
.....*Culex basicinctus* Edw.
- Dorsal area of vertex brown to gray-brown, with a lateral triangular white patch.....8

8. Fore tibia with a row of white spots in front; dorsal, basal, abdominal bands generally produced in middle.....*Culex annulirostris* Skuse
- Fore tibia without a row of white spots in front; dorsal, basal, abdominal bands approximately equal in width, at least on segments III and IV.....*Culex jepsoni* Theo.
9. Dorsal basal abdominal bands present.....10
- Dorsal abdominal bands lacking (at least no complete bands on the first three segments).....11
10. Mesonotum dark brown and with two lines of narrow, golden brown scales forming a lyre; two pairs of black triangular-shaped markings on lateral aspect of mesonotum.....*Culex pacificus* Edw.
- Mesonotum light brown, without such markings, uniformly covered with narrow, curved, golden-brown scales; a patch of broad, pale scales low down on either side of the head.....*Culex quinquefasciatus* Say.
11. Basal lateral spots of abdominal segments somewhat rectangular; palpi of male very short, no longer than in the females.....*Culex femineus* Edw.
- Basal lateral spots of abdominal segments very small; antennae of male with modified hairs (scale-like) on segments 6 to 9.....*Culex fraudatrix* Theo.
12. Strongly ornamented species (with prominent silver markings).....13
- Dark species with little ornamentation.....15
13. Mesonotum with four silvery lines, the outer pair curved to form a lyre-shaped marking.....*Aedes aegypti* Linn.
- Mesonotum with a narrow mid-dorsal silvery line and a silvery lateral band.....14
14. Dorsal abdominal bands on segments III to VII complete.....*Aedes hebrideus* Edw.
- Dorsal abdominal bands on segments III to VII broken medially.....*Aedes pernotatus* F. & B.
15. Dorsal abdominal bands lacking.....*Aedes daggyi* S. & B.
- Dorsal abdominal bands present.....16
16. Dorsal abdominal bands median and in an inverted "U"-shape.....*Aedes funereus ornatus* Theo.
- Dorsal abdominal bands basal.....17
17. Wings with at least some white (or yellowish-white) scales.....*Aedes vigilax* Skuse
- Wings entirely dark scaled.....*Aedes vexans* Meigen.

ANOPHELES (MYZOMYIA) FARAUTI LAVERAN

Larvae: Dry season breeding places for *farauti* in the New Hebrides consist primarily of rivers, streams, springs, seepage areas, ponds, taro gardens under water, swamps, and open wells located near native plantations.

During the rainy season, breeding may occur in almost all the additional water collections which form. At this time larvae may be found in all types of natural and man-made catchments, such as ruts, foxholes, bases of uprooted trees, borrow pits, poorly graded ditches, and in such places as hog wallows and occasionally in coral pools above the high tide level. Larvae are rather commonly discovered in such artificial containers as large tin cans, empty gasoline and oil drums, watering troughs, tubs, and occasionally in beached boats. The water in the above-mentioned types of breeding places may be clear, turbid, somewhat stagnant, brackish, or pure rain water. In nearly all cases, breeding in extensive water areas is associated with flotage or emergent vegetation. However, in small confined places such as pools, puddles, and road ruts larvae will commonly be found on the open surface, without any surface obstructions.

Larvae are rarely collected in coconut halves, tree holes, or in the axils of water-holding plants. Occasional ones have been reported in small tin cans and in coconut halves which were subject to flushing with rain water; however, this type of breeding place is the exception rather than the rule. Larvae were easily collected in swamps or pot holes that contained lodged mats of floating duckweed (*Lemna*). When the plants were scattered, a few were reported, but pools remained consistently free of anophelines in heavily covered pond surfaces.

Adults: Readily attack man. Most important anopheline as a vector of malaria and filariasis in the New Hebrides-Solomon Islands. Diurnal resting places consist of native huts, darkened quarters of military personnel, and tree buttresses in shaded jungle areas.

TRIPTEROIDES (MIMEOTOMYIA) CALEDONICA EDW.

Larvae: These rather unusual looking larvae are found primarily in tree holes, axils of pandanus trees, sago palms, and banana-like plants. They are also found in coconut halves and husks, bamboo stumps, and artificial containers such as tin cans, sagging tent covers, tarpaulins, and wooden frames holding water.

The larvae have a woolly appearance due to numerous spine-like setae on the thorax and abdomen. There is a marked variation in the length of the air tube and also in the chaetotaxy of the abdomen of the larvae and pupae of this species.

Adults: The adults have not been collected while biting man. They are collected freely resting on tree trunks.

MANSONIA (COQUILLETIDIA) XANTHOGASTER EDW.

Larvae: The larvae and pupae of this interesting genus have a peculiarly adapted air tube modified for piercing the roots or stems of aquatic plants.

On Espiritu Santo they are collected primarily from aquatic plants in large permanent fresh water swamps. *Mansonia* larvae and pupae have been collected in the field from several types of aquatic plants, but have been recorded most abundantly attached to the roots of the small clump-like *Pandanus*. In the laboratory they have been observed attached to the slender stems of certain floating plants such as duckweed (*Lemna*) and to the fleshy roots of the white water lily (*Nymphaea*).

Adults: Adults rest primarily on vegetation near the immediate vicinity of their breeding sites. They are persistent and vicious biters particularly near breeding areas. They bite during the day and early morning hours.

URANOTAENIA TIBIALIS TAYLOR

Larvae: The aquatic forms are collected in grassy swamps, densely shaded jungle swamps, the overflow of streams, and shallow pools formed along receding streams.

These larvae resemble anopheline larvae in their resting positions at the surface of the water. They are readily identified by their long spike-like head hairs.

Adults: Adults rest on tree buttresses and overhanging stream banks in the jungle. They are not known to bite man.

CULEX (MOCHTHOGENES) FEMINEUS EDW.

Larvae: The larvae of this species are most frequently found in rock pools along the sides of streams. They have occasionally been reported breeding in abandoned road ruts, open native wells, and partially submerged oil drums. One report has been made of its breeding in a tree hole. This is a fairly abundant species where favorable larval habitats occur.

Adults: Adults are collected at will resting upon tree trunks and moist overhanging banks. They are not known to bite man.

CULEX (CULEX) BASICINCTUS EDW.

Larvae: This species is a rather rare mosquito in the New Hebrides. The larvae are found in association with various types of *Spirogyra*. They have been collected among algae along river margins and in the ox-bows of rivers formed during the dry season. The apico-dorsal hairs on the air tube are modified to form stout recurved spines which are used in clinging to the filamentous mats.

Adults: Adults have not been collected attempting to bite man. Because of restricted breeding areas, adults are difficult to collect in nature.

CULEX (LOPHOCERATOMYIA) FRAUDATRIX THEO.

Larvae: These larvae have been found in shaded areas in permanent swamps among the roots of trees, along shaded, grassy stream margins, and occasionally in rocky pools and abandoned road ruts. The air tube of the larva is very long (9:1) and the ventral hair tufts are small and rather inconspicuous. Occasionally a dark median band is present on the air tube.

Culex hilli buxtoni and *Culex fraudatrix* are now considered to be synonymous.

Adults: Adults do not attack man readily. They are easily collected in the vicinity of breeding areas resting on vegetation, tree trunks, and overhanging protected stream banks.

CULEX (CULEX) JEPSONI THEO.

Larvae: In the New Hebrides the larvae of this species are found most characteristically in water collections in coral or sand pockets formed above high tide level. Reports have been made of its breeding in barrels and tin cans along beaches, in rain puddles, and in brackish water ditches. This species is characteristically coastal in distribution and where locations are found favorable for breeding, the larvae are very numerous.

Australian records of *Culex sitiens* are considered to belong to *Culex jepsoni*.

Adults: Adults have not been collected biting man.

CULEX (CULEX) ANNULIROSTRIS SKUSE

Larvae: These common larvae are taken in sunny areas of permanent swamps, road ruts, ditches, ponds, hog wallows, bases

of uprooted trees, and other natural catchments. They are seldom taken in confined places like tin cans, tree holes, or coconut shells. The length of the air tube varies from 4.5:1 to 8:1. Usually larvae taken from swamps and ponds containing relatively fresh water and abundant duckweed (*Lemna*) possess a noticeably slender air tube with an index close to 8:1. Those commonly collected in road ruts and other temporary ground pools and catchments possess a short tube with a siphon index of 4.5:1 to 6:1.

Adults: Adults attack man readily in the late afternoon and evening, and occasionally in the shade during the day. This species is the most common mosquito taken in routine night catches.

CULEX (CULEX) QUINQUEFASCIATUS SAY.

Larvae: This species is primarily a domestic mosquito. The larvae are found in various artificial receptacles near plantation homes and native huts. The larvae of *Culex quinquefasciatus* and *Culex pacificus* resemble each other very closely and are often difficult to separate from one another.

Adults: Adults bite readily at night. They rest primarily in quarters of military personnel and in native huts. In nature large numbers have been collected resting in tall grass and other emergent vegetation in the breeding area.

CULEX (CULEX) PACIFICUS EDW.

Larvae: Larvae are primarily found breeding in tree holes and cavities holding water. They are commonly collected in tin cans, artificial containers, and occasionally in coconut shells and plant axils. This is a rather abundant species.

Adults: Adults apparently do not attack man.

AEDES (AEDES) FUNEREUS ORNATUS THEO.

Larvae: These larvae are found in temporary rain pools, road ruts, hog wallows, and occasionally in ditches. They are often found in association with larvae of *Aedes vexans*. It is not a common larva considering how infrequently the adults are seen.

Adults: Adults attack man readily in jungle areas. This species is one of the most vicious day biters.

AEDES (AEDIMORPHUS) VEXANS MEIGEN

Larvae: Larvae are usually collected in temporary rain pud-

dles but are occasionally found in grassy swamps and drainage ditches following rains.

Adults: Adults attack man readily in the vicinity of breeding areas.

AEDES (GEOSKUSEA) DAGGYI STONE AND BOHART

Larvae: To date these larvae have been collected from crab and lobster holes near fresh water swamps or in brackish water near the ocean. This is a difficult larva to find and may be easily overlooked due to its light appearance and habit of remaining submerged for long periods of time. Occasional ones have been collected from temporary ground pools, probably due mainly to the flooding of crab and lobster holes during periods of heavy rains. There appears to be a fresh and a salt water variety. *Daggyi* is commonly taken in crab holes located near the ocean.

Adults: Adults are not known to bite man.

AEDES (STEGOMYIA) AEGYPTI LINN.

Larvae: This well known domestic mosquito is usually found in artificial containers near plantation homes and native villages. It is very common in rain barrels, buckets, and most any kind of artificial container. They have been recorded in large numbers breeding in salvaged tire casings.

Adults: Adults attack man readily and are well known for their bloodsucking habits. This species is the important vector of dengue in the New Hebrides.

AEDES (STEGOMYIA) PERNOTATUS F. & B.

Larvae: The larvae are occasionally found with *hebrideus* breeding in water held in wooden frames or coconut husks, but they are also found in tree holes and tree cavities. The larvae are not as abundant as *hebrideus* which they closely resemble.

Adults: Adults were not collected biting man in nature. They are reluctant to feed even under insectary conditions, although occasional ones have been induced to take a human blood meal.

AEDES (STEGOMYIA) HEBRIDEUS EDW.

Larvae: This is a common larva found in tree holes, coconut husks and shells, sagging tents and tarpulins, wooden frames, rain barrels, and artificial containers of all types.

Adults: Adults attack man readily and are persistent biters during the day.

AEDES (OCHLEROTATUS) VIGILAX SKUSE

Larvae: This is a salt and brackish marsh species. Larvae were collected by the author on one occasion in 1944 on Espiritu Santo from a salt water pool located above high tide level. This one collection probably represented an introduction from Noumea, New Caledonia, for it is not generally distributed in the New Hebrides. This was the first positive record of its presence in the New Hebrides.

Adults: Adults attack man readily during the day and are vicious and annoying biters.

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LONGEVITY OF TRICHODES AND PELONIUM LARVAE

Recently a number of clerid larvae were examined which had been collected in 1940 and 1941 in connection with a study of the life history of *Trichodes ornatus* Say¹. One example, taken as a fifth instar larva from the cells of *Odynerus blandinus* Cresson on December 24, 1940, completed its development and transformed to an adult between April and September, 1945, after a larval life of at least five, and possibly six, years, the period since 1940 having been spent without food. A second larva, which last accepted food on June 30, 1941, transformed in the same period after a larval life of four years. A third individual is still alive after four years and seven months, having spent the last four years and five months without food (in the fourth, fifth, and sixth larval instars). A larva from a nest of *Hoplitis productus* (Cresson), previously reported¹ as *Trichodes ornatus*, completed its development between April and September, 1945, and proved to be *Pelonium fasciatum* (Lec.) (det. W. F. Barr). It had been collected on August 10, 1939, and had accepted no food in the interim.—E. G. LINSLEY and J. W. MACSWAIN.

¹ Linsley, E. G. and J. W. MacSwain, 1943. Observations on the life history of *Trichodes ornatus* (Coleoptera, Cleridae), a larval predator in the nests of bees and wasps. Ann. Ent. Soc. Amer., 36:589-601, 2 pls., 1 t. fig.